HUMIDITY MEASUREMENT

Abstract

- Humidity is the amount of water vapor present in the air. Water vapor is the gaseous state of water and is invisible. Humidity indicates the likelihood of precipitation, dew, or fog. Higher humidity reduces the effectiveness of sweating in cooling the body by reducing the rate of evaporation of moisture from the skin. This effect is calculated in a heat index table or humidex . The amount of water vapor that is needed to achieve saturation increases as the temperature increases. As the temperature of a parcel of water becomes lower it will eventually not reach the point of saturation without adding or losing water mass.

Humidity can be classified into :

- Absolute Humidity
- Relative Humidity

Absolute Humidity

- Absolute humidity is the total mass of water vapor present in a given volume of air. It does not take temperature into consideration. Absolute humidity in the atmosphere ranges from near zero to roughly 30 grams per cubic meter when the air is saturated at 30 °C (86 °F).
- Absolute humidity is the mass of the water vapor , divided by the volume of the air and water vapor . The absolute humidity changes as air temperature or pressure changes. This makes it unsuitable for chemical engineering .

Relative Humidity

- **Relative humidity** (**RH**) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. Relative humidity depends on temperature and the pressure of the system of interest. It requires less water vapor to attain high relative humidity at low temperatures; more water vapour is required to attain high relative humidity in warm or hot air. The relative humidity (RH} of an air–water mixture is defined as the ratio of the partial pressure of water vapor (PH_20) in the mixture to the equilibrium vapor pressure of water (P^*_{H20}) a flat surface of pure water at a given temperature :
- $RH = PH_20 / P^*_{H20}$
- Relative humidity is normally expressed as a percentage ; a higher percentage means that the air–water mixture is more humid ; a lower percentage means that the air-water mixture is less humid .

Calculation Of Relative Humidity

- The amount of water vapor in the air at any given time is usually less than that required to saturate the air. The relative humidity is the percent of saturation humidity , generally calculated in relation to saturated vapor density.
- Relative Humidity = Actual Vapor Density / Saturation Vapor Density * 100 %
- The most common units for vapor density are gm/m^3.

Humidity

1. Humidity is the amount of water vapour in the atmosphere .
2. Humidity is the water content of the mixture of water vapour and other element found in the air .
3. Humidity is used to determine the likelihood of precipitation , fog or dew .
4. Determining the humidity of a certain place provides a way to gauge the weather .

Relative Humidity

1. Relative humidity is one type of humidity .
2. Relative humidity is the percentage of water vapour in the air at a given temperature .
3. Relative humidity is used for climate control and how it affects the health, comfort and safety of humans .
4. Relative humidity is also used to ensure of machines, vehicle and buildings.

Types Of Hygrometer's

Classical Hygrometer's

1. Metal-paper coil type
2. Hair tension hygrometer
3. Pyschrometer (wet and dry bulb hygrometer) : Sling pyschrometer
4. Chilled mirror dew point hygrometer

Modern Hygrometer's

1. Capacitive
2. Resistive
3. Thermal
4. Gravimetric

Hygrometer

- A hygrometer is an instrument used for measuring the moisture content in the atmosphere. Humidity measurement instruments usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By calibration and calculation, these measured quantities can lead to a measurement of humidity. Modern electronic devices use temperature of condensation (the dew point), or changes in electrical capacitance or resistance to measure humidity differences.

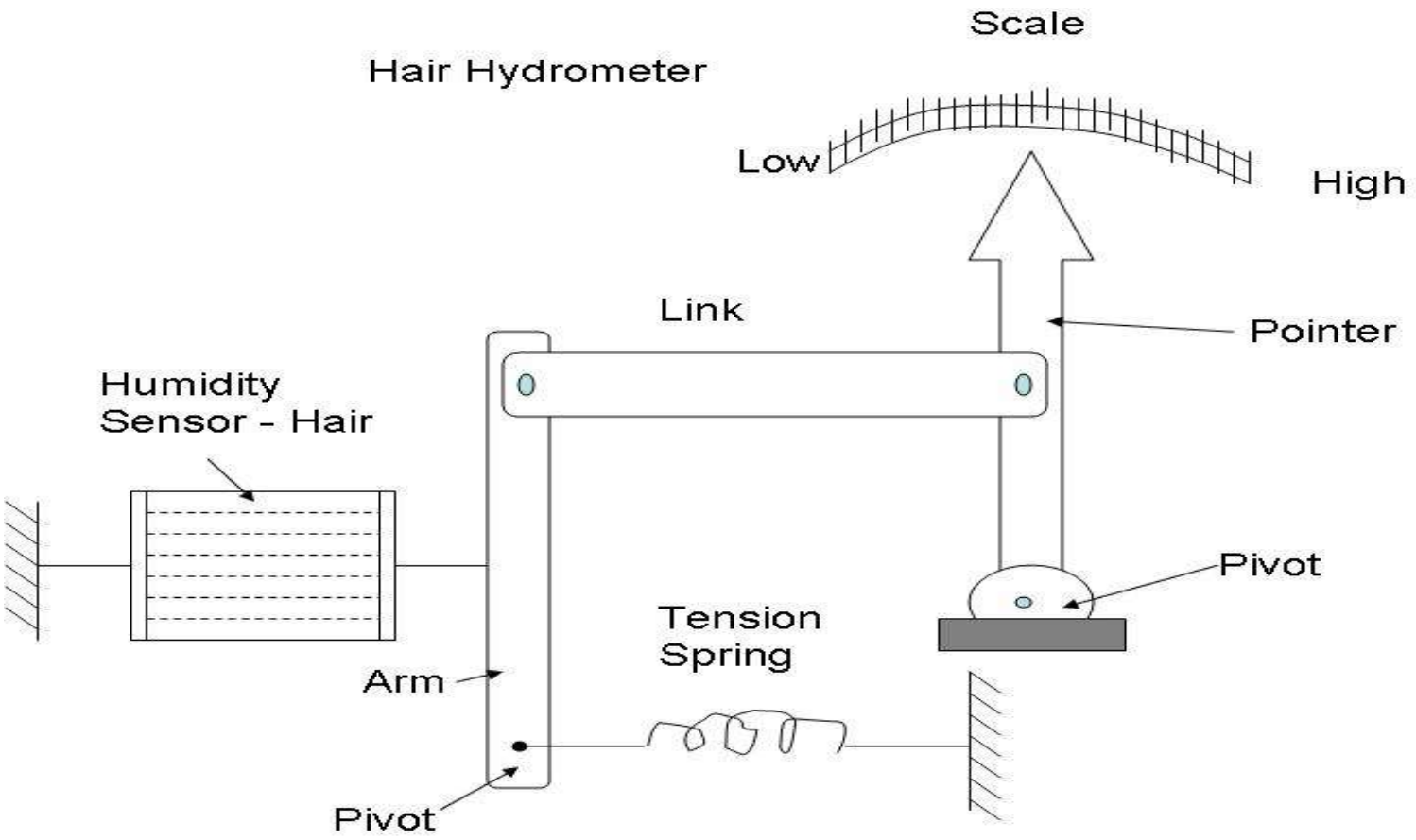
Basic Principle :-

- Due to humidity, several materials experience a change in physical, chemical and electrical properties. This property is used in transducer that are designed and calibrated to read relative humidity directly. Hair hydrometer is a type of absorption hydrometer and uses the mechanical humidity sensing technique. Certain hygroscopic materials such as human hair, animal membranes, wood, paper, etc., undergo changes in linear dimensions when they absorb moisture from their surrounding air. This change in linear dimension is used as the measurement of humidity present in air.

Description :-

- Human hair is used as the humidity sensor. The hair is arranged in parallel beam and they are separated from one another to expose them to the surrounding air/atmosphere. Number of hairs are placed in parallel to increase mechanical strength. This hair arrangement is placed under small tension by the use of a tension spring to ensure proper functioning. The hair arrangement is connected to an arm and a link arrangement and the link is attached to a pointer pivoted at one end. The pointer sweeps over a humidity calibrated scale.

Hair Hygrometer



Human hair has a property that its length increases when it is wet and its length decreases when it goes dry .

Operation :-

- When the humidity of air is to be measured, this air is made to surround the hair arrangement and the hair arrangement absorbs the humidity from the surrounding air and expands or contracts in the linear direction. This expansion or contraction of the hair arrangement moves the arm & link and thus the pointer to a suitable position on the calibrated scale and thus indicating the humidity present in the air/atmosphere.

- Precaution : These Hair hydrometers are called membrane hydrometers when the sensing element is a membrane.

Applications :-

- ✓These hydrometers are used in the temperature range of 0’C to 75’C.
- ✓These hydrometers are used in the RH (Relative Humidity) range of 30 to 95%.

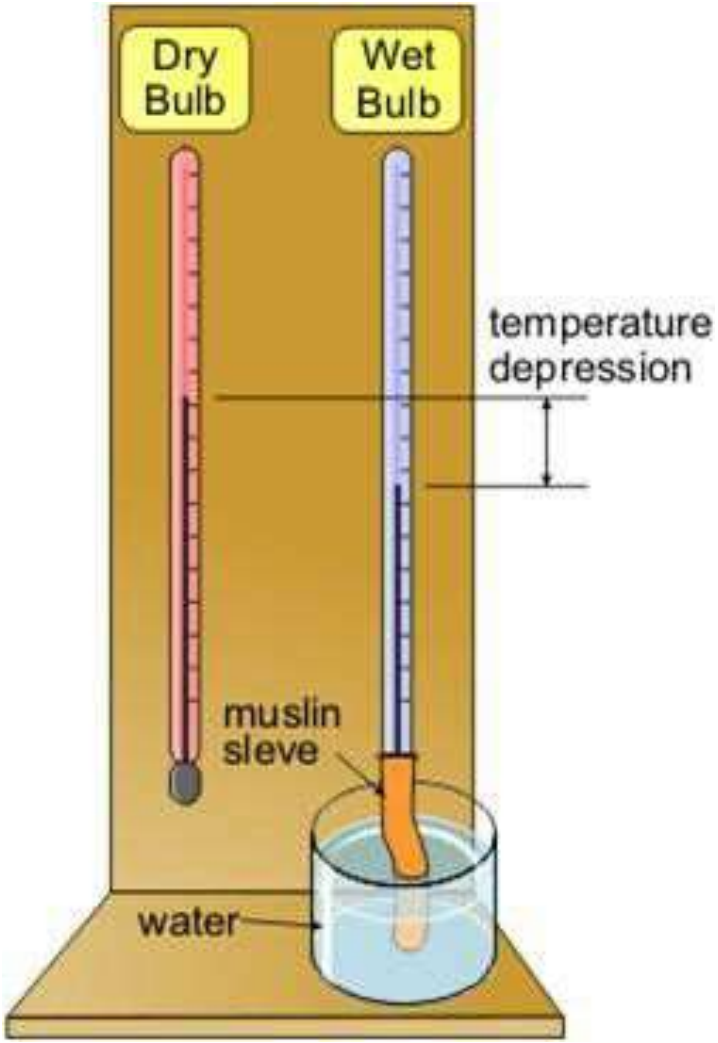
Disadvantage :-

- ✓These Hydrometers are slow in Response .
- ✓If the Hair hydrometer is used constantly, its calibration tends to change.

Wet & Dry Bulb Hygrometer

- A pyschrometer or wet & dry bulb thermometer , consist of two thermometers , one that is kept moist with distilled water on a sock or wick . At temperatures above freezing point of water evaporation of water from the wick lower temperatures so that the wet-bulb usually shows a lower temperature than that of the dry-bulb thermometer . When the air temperature is below freezing , however the wet-bulb is covered with a thin coating of ice and may be warmer than the dry bulb .
- Dry-Bulb temperature (DBT) :- The dry-bulb temperature is the temperature indicated by a thermometer exposed to the air in a placed sheltered from direct solar radiation . The term dry-bulb is customarily added to the temperature to distinguish it from wet-bulb and dew-point temperature .
- Wet-Bulb temperature (WBT) :- The thermodynamic wet-bulb is a thermodynamic property of mixture of air and water vapor . The value indicated by a wet-bulb thermometer often provides an adequate approximation of the thermo-dynamic wet-bulb temperature .

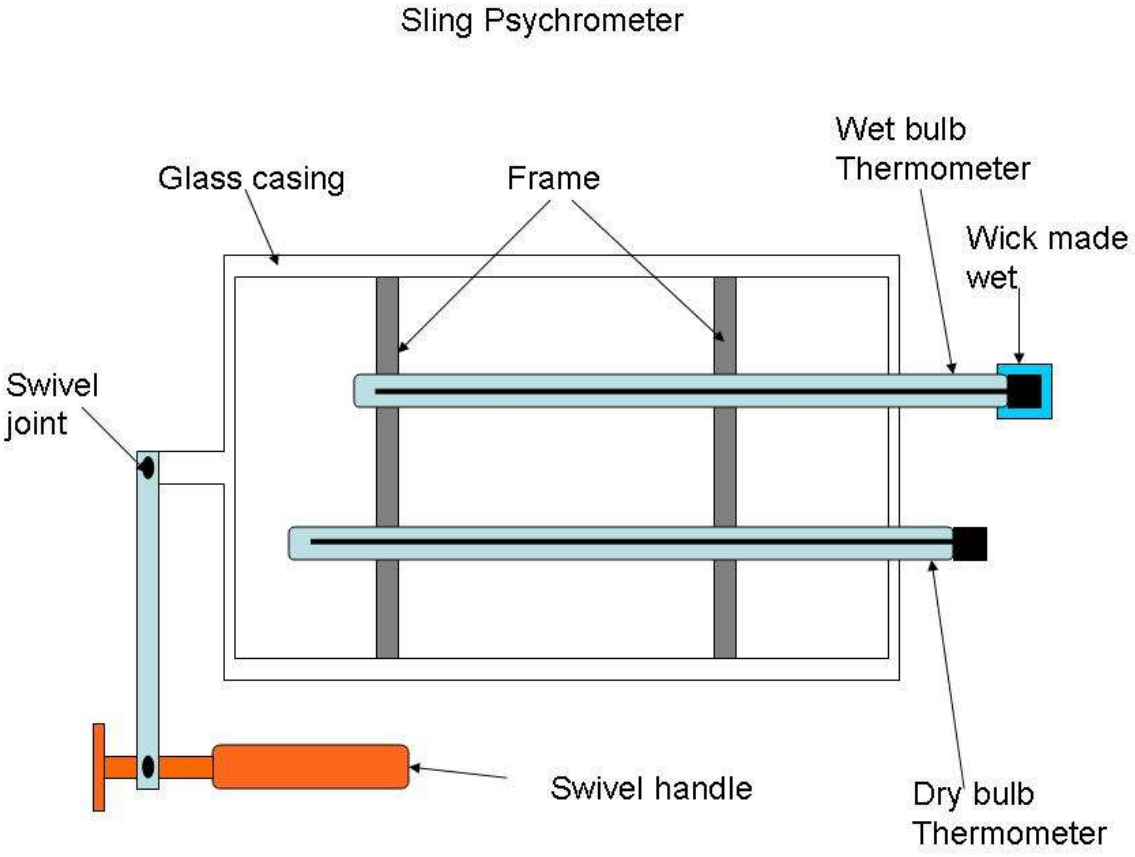
Wet & Dry Bulb Hygrometer



Sling Pyschrometer :-

- A sling psychrometer, which uses thermometers attached to a handle or length of rope and spun in the air for about one minute, is sometimes used for field measurements, but is being replaced by more convenient electronic sensors. A whirling psychrometer uses the same principle, but the two thermometers are fitted into a device that resembles a ratchet or football rattle.

Sling Psychrometer



Operation :-

- In order to measure the dry bulb and wet bulb temperature, the Psychrometer frame – glass covering – thermometer arrangement is rotated at 5 m/s to 10 m/s to get the necessary air motion. The thermometer whose bulb is bare contacts the air indicates the dry bulb temperature. At the same time, the thermometer whose bulb is covered with the wet wick comes in contact with the air and when this pass on the wet wick present on the bulb of the thermometer, the moisture present in the wick starts evaporating and a cooling effect is produced at bulb. Now the temperature indicated by the thermometer is the wet bulb thermometer which will naturally be lesser than the dry bulb temperature.

Precautions :-

- If the Psychrometer is rotated for a short period, then the wet bulb temperature recorded will not be proper. If the Psychrometer is rotated for a longer period, the wick will get dried soon and the wet bulb temperature will not be at its minimum value.

Application :-

- ✓ It is used for checking humidity level in air-conditioned rooms and installations.
- ✓ It is used to set and check hair hygrometer.
- ✓ It is used in the measurement range of 0 to 100% RH.
- ✓ It is used for measuring wet bulb temperature between 0’C to 180’C.

Disadvantage :-

- ✓ The measured medium is disturbed due to the act of measurement. The evaporation process at the wet bulb will add moisture to the air.
- ✓ It cannot be used in automation requirement situations.
- ✓ It cannot be used for continuous recording purpose.
- ✓ If the wick is covered with dirt, the wick will become stiff and its water absorbing capacity will reduce, however, a stiff/dirty wick will resume normalcy when boiled in hot water.